Biogeography of Luzon Island, Philippines

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Abstract: Luzon Island is the largest and oldest of the oceanic islands of the Philippine archipelago. Previous biogeographic research has determined centres of endemism within the island. While the Pleistocene Aggregated Island Complex theory defines the island as one biogeographic region, recent phylogenetic studies suggest that the island may be composed by distinct centres of endemism that correlate with tectonic features. Deep genetic divergence between northern Luzon and southern Luzon clades support this hypothesis. Past researches have downplayed the importance of vicariance in the modern biogeography of the island. However post vicariance dispersal may have obscured historical and area relationships that are noted in coalesced islands. Nonetheless, the molecular phylogenetic signature of pre Pleistocene vicariant events are there and further phylogenetic studies may clarify these relationships.

Key words: Pleistocene Aggregated Island Complex (PAIC), vicariance, dispersal, Luzon, Philippines, biogeography.

Introduction

This essay builds upon the biogeographical hypotheses on the Philippines position in Wallacea in Volume 1 of this book series. In my "The Philippines in Wallacea" I propose looking at the biogeography of the Philippines beyond the Pleistocene Aggregation Island Coalescence (PAIC) theory (Vallejo 2011). Here I focus on Luzon, the oldest of the oceanic Philippine islands. Luzon is the largest (104 688 km^2) island of the Philippine archipelago. The roughly rectangular island is orientated with its longest axis north to south from 18°32'N to 12°31'N (Fig. 1). The shape of the island gives rise to its name. The island resembles the traditional rice pestle or "lusong" of the Austronesian people.

The southern and south-eastern portion of the island is composed of a series of peninsulas trending southeast for about 150 km (Fig. 2). The northern end of the island are composed of several mountain blocs, most notable of which is the Cordillera Central whose mountains attain an altitude of more than 2000 meters. A large central plain defines the central portion of the island. This is bordered on the west by the Zambales mountain ranges. The eastern side of the island is defined by the Sierra Madre mountain range that trends from north to south. At its northern end, a large valley, the Cagayan Valley is situated between the Sierra Madre to the east and the Cordillera Central to the west.

The latitudinal extent of Luzon and the complexity of its topography and the presence of intermontane valleys of varying sizes ensure a diversity of climate not observed anywhere else in the Philippine archipelago (Dickerson et al. 1928). The altitude of the landforms and their exposure to the prevailing monsoon and trade winds generally defines the climate of the island.

Tectonics of Luzon Island

The complex topography has tectonic origins. The island is hypothesized as a product of the accretion of at least four paleoislands (Hall 1996, 1998). The paleoislands correspond to the five montane regions of Luzon (Devan-Song et al. 2012). The island is part of the Philippine Mobile Belt (PMB) that defines the seismically active part of the archipelago (Gervasio 1967). The island being part of the PMB is bounded by two subduction zones of opposite polarities. The eastern side is bounded by the west dipping Philippine Trench and the western side is by the east dipping Manila Trench. New geophysical evidence suggests that the Benham Rise oceanic plateau east of Luzon has a thicker crust than what can be expected for oceanic crust (Lagmay et al. 2009). This feature began colliding with northern Luzon starting in the Miocene thereby profoundly affecting Luzon's tectonic evolution.
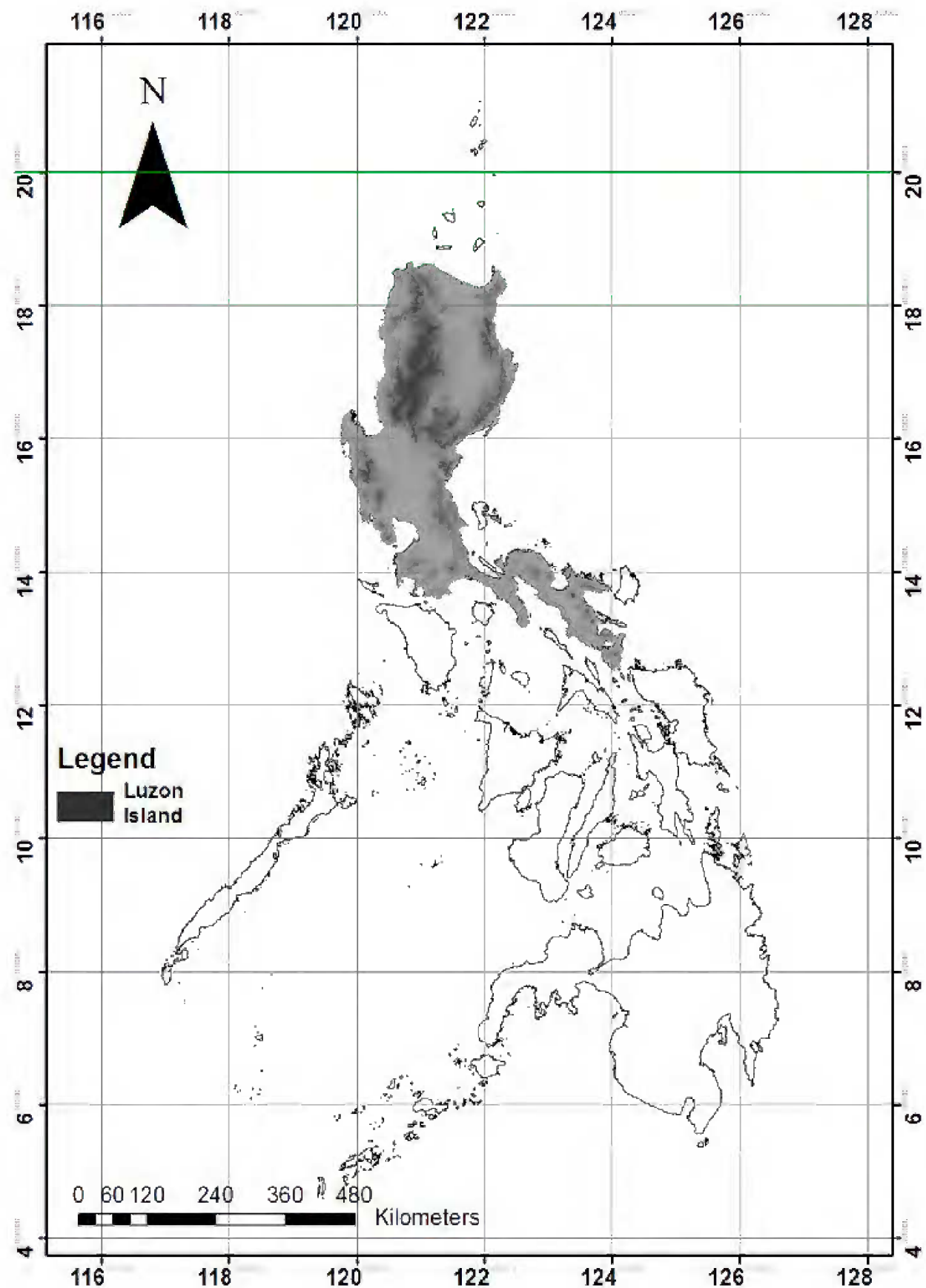
Figure 1. Luzon Island in the Philippine archipelago.

The Philippine archipelago and most especially Luzon Island is defined by the left lateral strike slip Philippine fault system which longitudinally cuts Luzon Island (Yumul et al. 2008) at Quezon and Nueva Ecija provinces. It originates from Davao Gulf in Mindanao, bisects Mindanao's Agusan basin, the passes through Leyte and Samar islands before terminating in Luzon's north-western coast. In Luzon the fault becomes braided (Fig. 3).

Thus with new geophysical data it is now possible to delineate the tectonic blocks that comprise Luzon. These blocks are mobile, elastic and are related to the major fault features in Luzon that absorb plate convergence such as the Philippine Fault, Digdig Fault and the Northern Cordillera Fault. From a biogeographic standpoint, blocks may correlate with patterns of endemism and distribution of Philippine biota. This is the hypothesis first proposed by Roy Dickerson and Elmer D Merrill in 1928 (Dickerson et al. 1928).

Dickerson's hypothesis

Roy Dickerson and associates of the Philippine Bureau of Science in "Distribution of Life in the
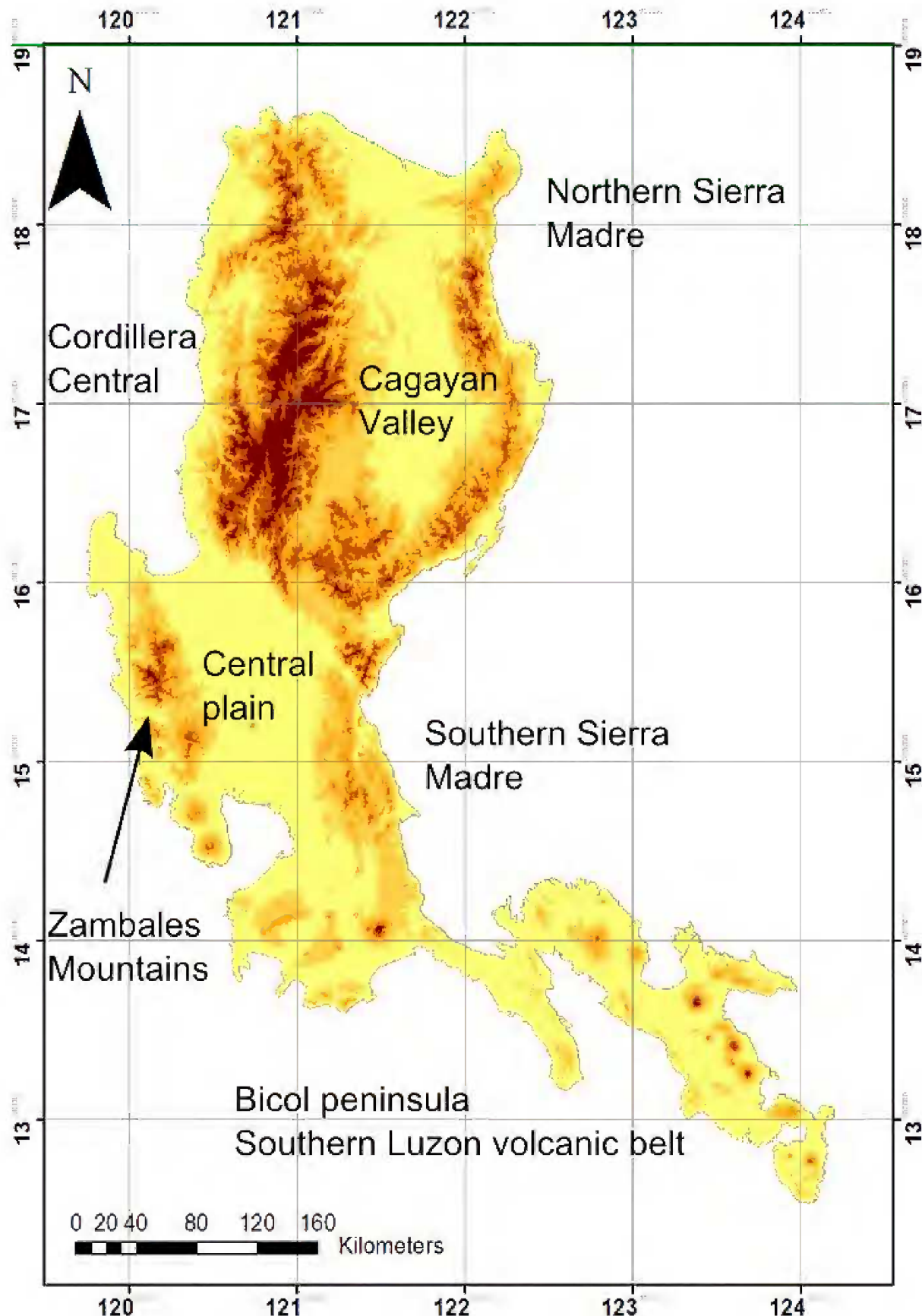
Figure 2. Major physical geographic features of Luzon Island.

Philippines" (1928) proposed that the geological features of the Philippine islands could partly explain the reason for the localization and endemism of the Philippine biota. Dickerson's hypothesis is based on the fifth axiom of biogeography (Wallace 1880) its emphasis on a general knowledge of geological history is necessary for understanding the evolution of the Philippine biota.

Dickerson interpreted the distribution of floral and faunal elements in the Philippines using the dispersalist paradigm. He proposed four colonization routes by which dispersal happened. These are the Palawan-Mindoro route, the Borneo-Sulu route,

the Sulawesi - Eastern Mindanao route and the Taiwan – Batanes - Northern Luzon route.

Luzon's biota provides support and difficulties for the dispersal hypothesis. Dickerson needed to explain the presence of the northern Luzon upland flora and fauna for which he had difficulties. While the phenomenon of continental drift had been hypothesized by Alfred Wegener in 1924 (Wegener 1966), the process by which this would happen had not been proposed. Without the explanatory power of plate tectonic theory, Dickerson had only the land bridge paradigm and the Wallace theory correlating emergence of islands with geological and
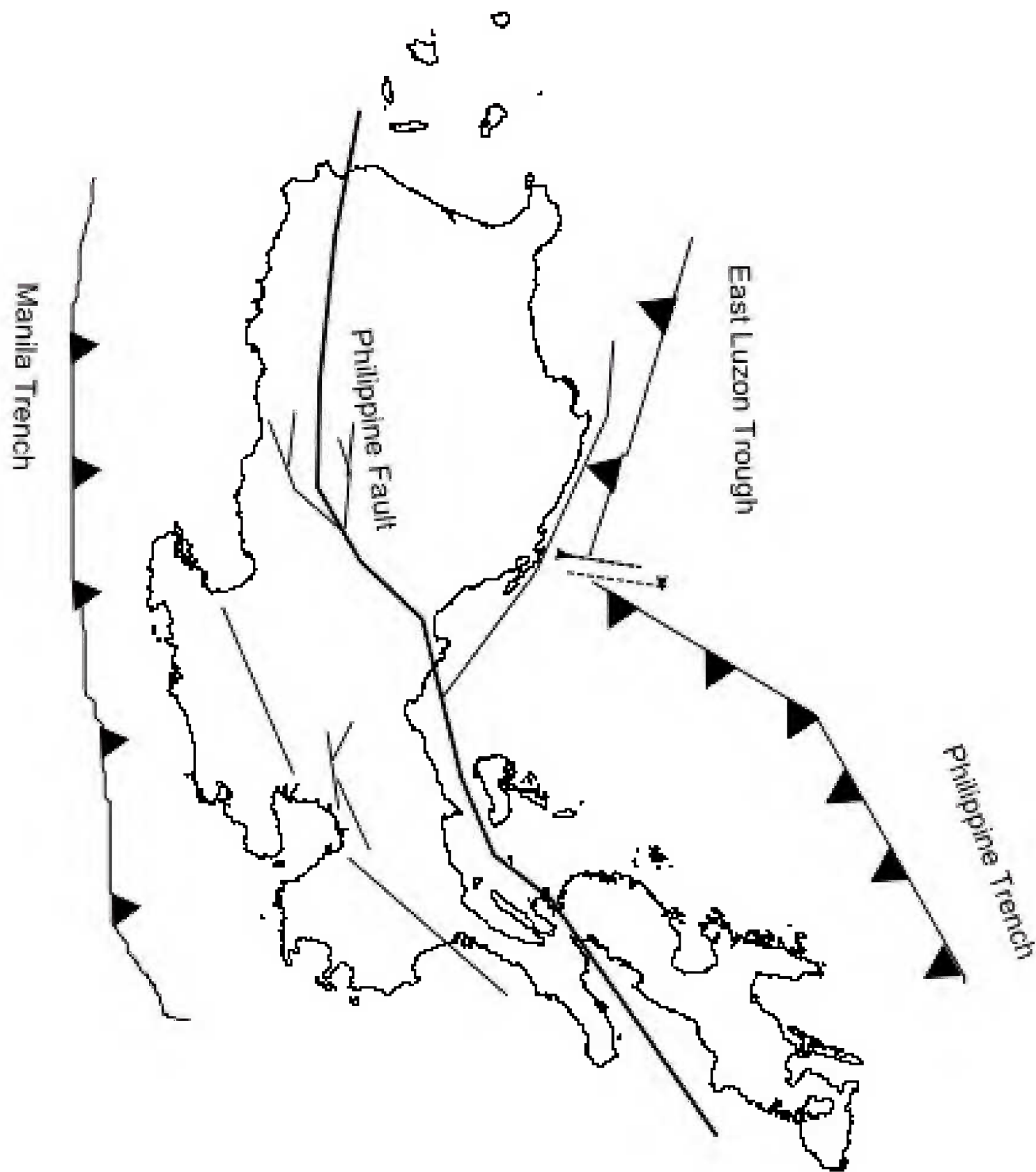
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Figure 3. Major tectonic features of Luzon Island (modified from the Philippine Institute of Volcanology and Seismology, 2013).

consequently phylogenetic age of the biota.

The lack of a comprehensive theory to relate the presence of Philippine floristic provinces (sensu Merrill) with tectonic features did not prevent Dickerson to hypothesize on the physiognomy of geographical features of the Philippine islands in geologic time. This radical speculation such as the possibility that Luzon and Mindanao were once separate archipelagic systems which he inferred from the distribution of the modern biota within each island, presaged the idea of island coalescence (Hall 1996, 1998) now known as the Pleistocene Aggregated Island Complex (PAIC) theory which forms the basis of the current idea explaining the presence of distinct island biotic regions in the Philippines (Heaney 1986, 1998, 1999, 2000).

Biotic alliances in the Philippines and the distinctiveness of Luzon (Fig. 4)

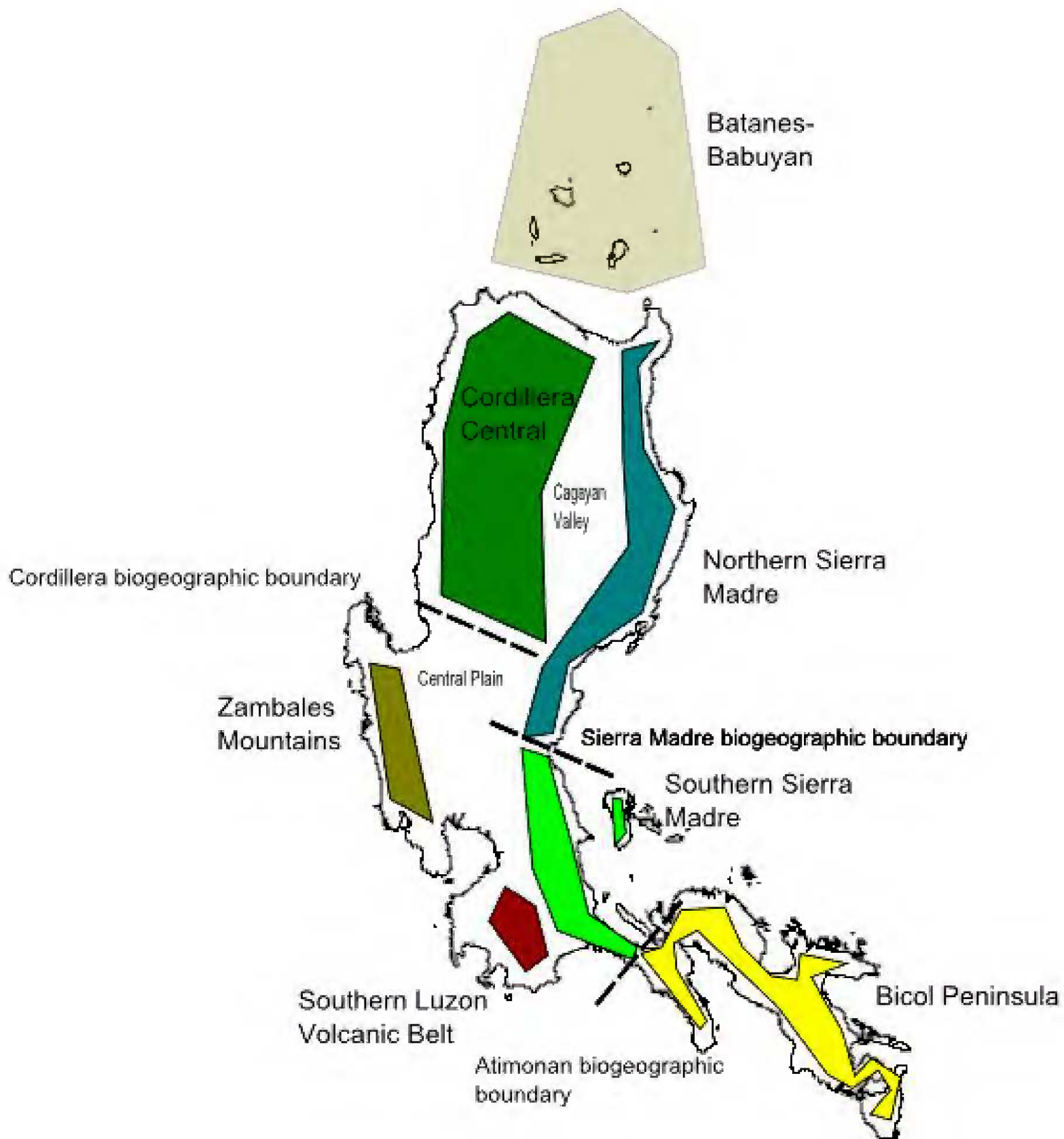Elmer D. Merrill (Merill 1923) observed that

Figure 4. Luzon biotic regions (after Merrill 1928, modified with new distribution and tectonics information).

when the Philippines is taken as a whole, its floral affinity with other regions in Southeast Asia is definitely Indo-Malayan with a high proportion of endemic species. While floral regions do exist, its distinctiveness is not sharp with the exception of the Luzon Cordillera flora. It is on Luzon in the Cordillera where a flora and fauna with obvious Himalayan affinities are found. On other islands, it is on high mountains where a distinct Sulawesian and Australian affinity can be found. The Cordillera flora with the exception of a few species is localized in the region. Merrill hypothesized a connection with Taiwan but came to conclude that out of the 1100 species found in Taiwan and could occur in the Cordillera given that the climate conditions are similar less than 265 occur on Luzon and in Taiwan. Thus puts a question on the land bridge connection of Luzon with Taiwan, which tectonic studies later would conclude as unlikely. Merrill in conformity with the land bridge paradigm suggests that only the Cordilleras were once connected with Taiwan and the rest of mainland Asia.

A dispersal process cannot be ruled out for a colonization route from Taiwan. Recent studies suggest that at least for one species of skink, there is evidence of dispersal from Taiwan (Esselstyn et al. 2010).

Microendemism and mountain regions in Luzon

Luzon has a high degree of microendemism across taxa which has been extensively studied for the herpetofauna (Siler et al. 2010, 2011, Devan-Song et al. 2012) and mammals (Heaney et al. 1998, Rickart et al. 2011). This microendemism is found mainly in the montane regions. For the herpetofauna, four to five regions with significant microendemism can be recognized. For the mammals, four regions of microendemism are recognized. These regions are:

1) The Zambales Mountains,
2) Cordillera Central Mountains,
3) Northern Sierra Madre Mountains, and
4) The Southern Sierra Madre Mountains and the Southern Luzon and Bicol volcanic belt.

Mt Pulag which lies in the Cordillera Central is a convergence zone of endemic flora with Gondwanan and Eurasian affinities (Buot Jr. et al. 1999).

Of all the four regions of microendemism, the Zambales and Cordillera mountains have received more research interest in the last 20 years. Zambales is relatively isolated from the rest of Luzon's mountains by the central Luzon plain (Brown et al. 1996). This mountain range is essentially an ophiolite complex (Yumul et al. 2003, 2008). Recent research indicates that the Zambales mountains as well as the nearby Cordilleras have substantial patterns of endemism in small mammals (Balete et al. 2009, Rickart et al. 2011). The Zambales mountains have been also identified as an endemic plant region (Merill 1923; Dickerson et al. 1928). For example the umbrella plant genus *Schefflera* J.R. Forst, G. Forst, 1775 has many endemics in the Zambales and Cordillera Central ranges (Frodin 1986) but none outside these areas.

Can Luzon be a case by which biological disjunctions can be examined as related to tectonic features?

The presence of one major fault system in the Philippine archipelago gives an opportunity for bio-geographers to examine whether biological disjunctions observed in Luzon and the four microendemic regions are congruent with tectonic features. In New Caledonia, Michael Heads in describes biodiversity with respect to the West Caledonian fault system by using molecular phylogenetic, tectonic and panbiogeographic methods to describe biotic disjunction with the fault system (Heads 2008). New Caledonia is an ancient remnant of Gondwana and is rich in archaic taxa. Heads hypothesizes that lateral strike slip fault systems may reveal more than biotic disjunctions that any other geological feature. In other island systems in the Pacific basin, such disjunctions have been also noted (Heads 1990, 2001, 2008) in studies in cladogenesis.

Two major schools of thought in biogeography examine the problem of disjunction and cladogenesis with respect to determining areas of endemism. In cladistic biogeography (Platnick et al. 1978, Nelson et al. 1981) especially in the parsimony analysis of endemism (PAE) approach, it is possible to come up with correct inferences to historical relationships among areas when by modelling a particular combination of vicariance and non-response to vicariance events (Brooks et al. 2003). In these cases, vicariance is wholly responsible for species distribution and species in each clade considered have a specific pattern of non-response to vicariance. These non-responses to vicariance generates the correct area relationships. Another model that generates correct historical and area inferences is when species distributions result from a particular combination of extinction events especially for wide ranging species. Extinction events may split ranges analogous to geological vicariance events. Brooks et al describe three cases when PAE methods fail. In the third case, post vicariance dispersal may obscure historical and area relationships. I hypothesise that the third case is likely for the Philippine archipelago.

Cladogenesis in Luzon

The general distribution of endemics in Luzon can be roughly characterized by a northern group and a southern group. The northern group clades consists of Zambales and Cordillera representatives and the southern group clades which includes species from the Bicol peninsula, have more affinity to representatives from the Visayas and Mindanao islands. In the fantail birds *Rhipidura* Vigors, Horsfield, 1827 (Sánchez-González et al. 2011), the older northern and southern clades have a deep

divergence suggesting an earlier colonization from mainland Asia (Fig. 5).

A similar hypothesis can be proposed for the murines of Luzon (Jansa et al. 2006). The "old endemics" which include *Crateromys* Thomas, 1895, *Phloeomys* Waterhouse, 1839 cloud rats, *Batomys* Thomas, 1895 and *Carpomys* Thomas, 1895 show a deep divergence within the group, with the northern Luzon species more basal than the southern representatives. The Luzon endemic *Phloeomys* Waterhouse cloud rat genus is represented by a northern Luzon and a southern Luzon species and is more basal than *Crateromys* Thomas. *Crateromys* shows similar distributions in its representatives although this genus has representatives in Mindoro, Panay and Dinagat Islands. The "old endemics" colonized evolved at least 22 My, when northern Luzon's older tectonic features emerged from the ocean. There is evidence that the "old endemics" have affinities to Australasian murine clades (Steppan et al. 2003) but are now extinct in the rest of Asia (Jansa et al. 2006). More recent phylogenetic data from seven newly identified species of *Apomys* Mearns, 1905 reinforce the hypothesis that northern Luzon has a distinct and endemic biota (Heaney et al. 2011) and that central Luzon is a biogeographic break.

In the biogeography of the Philippine varanids, the northern and southern Luzon disjunction can be noted (Welton et al. 2010). The northern Luzon endemic *Varanus bitatawa* Welton, Siler, Bennett, Diesmos, Duya, Dugay, Rico, Van Weerd, Brown, 2010 is morphologically distinct from the southern Luzon and Bicol peninsular endemic *V. olivaceus* Hallowell, 1856. Both species are frugivorous. In total there are three frugivorous species of *Varanus* Merrem, 1820 in the world which includes *V. mabitang* Gaulke, Curio, 2001 from northern Panay (Gaulke et al. 2001).

These frugivorous varanids are associated with old growth rainforests which exists along the eastern Philippines bioregion. *V. bitatawa* and *V. olivaceus* are sister species, albeit with deep genetic divergence and their ranges are separated by the lower elevations of the southern Sierra Madre ranges (Fig. 6). The southern Sierra Madre is the eastern Luzon terminus of the active Philippine Fault (Yumul et al. 2008). While the southern Sierra Madre ranges which are very near to Manila have been historically deforested, they were unlikely to have been prior to human settlement. Thus it would have been possible for limited dispersal of the northern species to southern Luzon. Similarly the southern species could have dispersed to Luzon.

However both species have evolved in higher montane forests and have unlikely to have dispersed through the lowland forests of the southern Sierra Madre. Nonetheless the distribution of endemic varanids of Luzon and even of Panay in the Visayas appear to be delimited by their tectonic features with *V. mabitang* localized in the Panay Cordilleras (Zamoras et al. 2008).

This distributional pattern is reflected in Philippine *Rafflesia* R. Brown (Barcelona et al. 2009) where *R. manillana* Teschem is localized to the Southern Luzon and Bicol Peninsula areas although some individuals were collected in Cagayan, northern Luzon. Luzon endemics of *Rafflesia* R. Brown have been collected in the Bicol peninsula and in the northern Sierra Madre ranges in Cagayan (Barcelona et al. 2006, 2009; Madulid et al. 2006). Panay also has its own endemic *Rafflesia* found in the Panay Cordilleras (Barcelona et al. 2002).

Revisiting PAIC theory

The Pleistocene Aggregated Island Complex (PAIC) theory (Brown et al. 2002) is the paradigm for explaining the origin and dimensions of biodiversity in the Philippines (Heaney 1986; Heaney 1998). The theory states that isolation and reconnection of islands that composed the palaeo "Greater Islands" of the Philippine archipelago provided the vicariant mechanism for speciation. Also differential dispersal abilities of the isolated species on the palaeoislands increased genetic isolation leading to speciation.

PAIC theory can adequately explain speciation of Philippine taxa within the last 5 million years. Thus it is not surprising that the theory can explain phylogenetic relationships in taxa in the younger Philippine islands. PAIC theory predicts the following (Esselstyn et al. 2010):

1) Populations in a given island should be more related from populations in other islands;
2) Populations within an island should be genetically more related than similar populations in other islands;
3) Monophyletic lineages should be found within one island and not across several islands.

Luzon being the oldest of the Philippine oceanic islands at 35 My and dating back to the Eocene presents complications to the PAIC theory. In contrast, predictions of PAIC is more easily verified for the younger PAIC islands like Negros and Panay
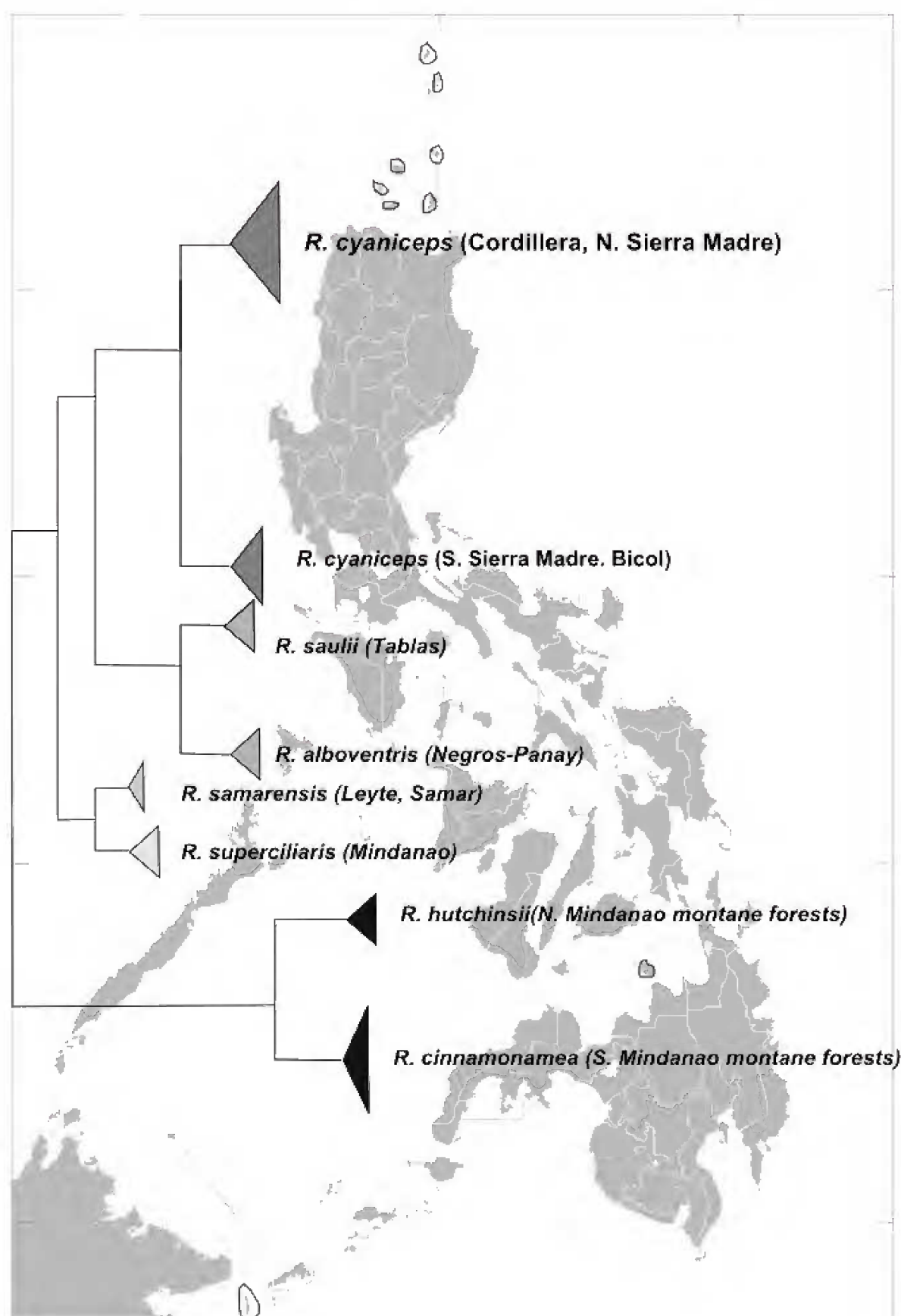
Figure 5. Phylogeny of endemic Philippine *Rhipidura* Vigors, Horsfield, 1827 (modified from Sanchez and Moyle, 2011).

(8-5 My) (Diesmos et al. 2002) in studies of phylogenies of reptiles and amphibians (Gaulke et al. 2007; Siler et al. 2007).

In Luzon, while there are taxa whose endemic status can be explained by PAIC, other factors that explain endemism need to be considered. One is the habitat preference of a taxon. In *Copsychus* Wagler, 1827 Magpie Robins and Shamas, the older species the Luzon Shama *C. luzoniensis* (Kittlitz, 1832) colonized Luzon and dispersed to Panay-Negros PAIC and persisted there since in those island, there were more habitats that suited it (Sheldon et al. 2009). Younger species originated from a more recent colonization from Sundaland in the last 5 My and they colonized Palawan and the oceanic islands of the central Visayas, where *C. cebuensis* (Steere, 1890) is an example. *Copsychus* can be divided into two ecological groups with the more vagile and coastal magpie-robins and the more inland rainforest dwelling shamas. The diversification of the latter in the Philippines can be easily explained by PAIC theory. In contrast the Philippine magpie-robins even in historically isolated Sibuyan Island have their nearest relations from species in ocean-
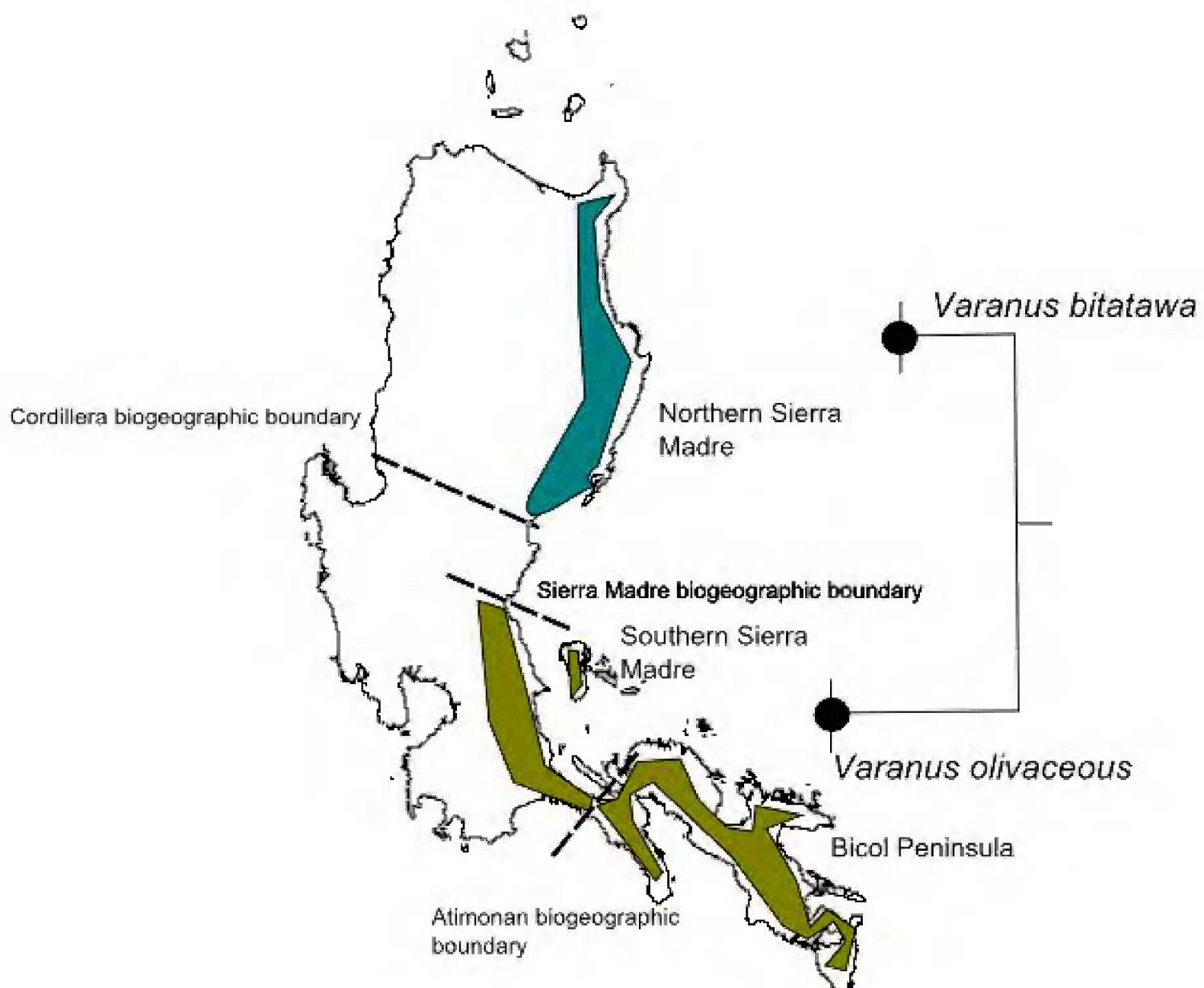
Figure 6. Distribution of Luzon's endemic varanids (after Siler et al. 2010).

ic Seychelles. Their affinities to presumed African ancestors imply a very early colonization through the Gondwana landmasses of India. This also is similar to the inferred phylogenetic history of the Philippine Eagle and its nearest extant related species, the Africal Bateleur eagle (Lerner et al. 2005; Vallejo Jr 2011). However based on the molecular phylogenetic data, *Copsychus* Wagler diversification in the Philippines can be dated to the early Pleistocene and Pliocene at the latest and possibly even earlier in the Miocene (Sheldon et al. 2009). Despite island coalescence as a result of sea level regressions, none of the Luzon and Negros- Panay PAIC species were able to colonize Mindanao.

Similar patterns of diversification can be noted in Philippine *Rhipidura* Vigors, Horsfield, 1827 (Fig. 5). Deep genetic divergences between and within PAIC islands species and populations indicate a pre Pleistocene colonization of the older PAIC oceanic

islands of Luzon, Mindanao and Negros-Panay.

However for taxa whose radiation occurred during the Pleistocence, the predictions of PAIC theory are well verified (Esselstyn et al. 2009) especially the isolation by distance model. However analysis of molecular variation (AMOVA) in these taxa shows the dominant role of intra-island isolation and breaks to gene flow. In fact this is the dominant proportion that accounts for genetic variation in the largest and oldest oceanic islands of Luzon and Mindanao (Esselstyn et al. 2009). A possible factor that generated this variation is sympatric speciation (Esselstyn et al. 2009) which may explain diversification in a coalesced island like Sulawesi (Esselstyn et al. 2009).
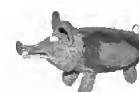
Distribution anomalies in northern Luzon, other factors for endemism

The current reconstructions of phylogenetic histories of amphibian and reptile taxa from northern Luzon show the affinities between the Zambales, Cordillera and Northern Sierra Madre mountains (Diesmos et al. 2004). One species of frog *Platymantis pygmaeus* Alcala, Brown, Diesmos, 1998 from is found in northern Luzon and in the oceanic island of Sibuyan in the Sibuyan Sea (Diesmos et al. 2004). Sibuyan island was never connected with any of the Pleistocene palaeoislands (Heaney 1998). Despite intensive sampling in similar habitats in southern Luzon and Bicol peninsula, the species was never recorded. Since *Platymantis* Günther, 1858 is rainforest associated does not disperse over the sea, this distribution remains enigmatic.

For the northern Luzon murines, it is possible that during the Pleistocene the extant Cordillera species or their close relatives were found in lower elevations. Archaeological excavations in Callao Cave, Peñablanca in Cagayan Province (85 m elevation) (17°42'11.74"N, 121°49'25.5"E) revealed the presence of *Apomys* Mearns and *Batomys* Thomas fossils. *Apomys* is found from Luzon, Mindoro, Negros, Panay to Mindanao having dispersed to these areas during the Pleistocene sea level regressions (Steppan et al. 2003). The phylogenetically older *Batomys* is found only in Luzon and Mindanao (Jansa et al. 2006) but now are found in higher elevations.

It is thus possible that the Pleistocene climate favoured the dispersal of the mountain murines of the Philippines across the Luzon central plains. If this is possible then other taxa with similar habitat requirements may have done so. However it is less likely that a close canopy lowland tropical rainforest existed in the Luzon Pleistocene. It is more likely that lowland rainforests contracted in the drier and cooler climate with some areas serving as refugia and stepping stones to dispersal (Schneider et al. 1999). This may also have been the factor for vicariant speciation. Also it is possible that the Pleistocene taxa were not as closely associated to rainforests as they are today but were more generalist (Heaney et al. 2011). Thus they could have dispersed through hypothesized montane forest refugia at lower elevations as has been demonstrated in the archaeological record in Papua New Guinea (Pasveer et al. 2002).

Integrating the paradigms, the Philippine islands as "mini-Sulawesis"?

Recent studies on the distribution and phylogeny of Luzon's endemic flora and fauna suggest that the Pleistocene Aggregated Island Complex (PAIC) theory to explain the evolution of biodiversity in the Philippines is simplistic and may apply only for the Plio-Pleistocene epochs. However since much of the species radiation occurred during this time period, especially for the small mammals, this pattern remains most observable. While phylogenetic reconstructions of species diversification support the PAIC theory, analysis of molecular genetic variation suggests intra-island isolation possibly by sympatry.

The dynamic geological history of Southeast Asia and most especially the Philippine archipelago provides many opportunities for colonization and allopatric diversification. Allopatric diversification is likely determined by the physical geography of the islands themselves. Luzon has the greatest estimate of nucleotide diversity in shrews and much of this occurred in the Holocene, as diversity has more correlation with the age and size of the modern island than that of the paleoisland (Esselstyn et al. 2009). This also implies the importance of orography and the likely influence of Holocene climate change which caused changes in vegetation and land cover. This may be a factor in the colonization of the Philippine islands by the bulbuls, where certain clades effectively colonized the oceanic islands and others only the continental islands (Oliveros et al. 2010).

Another factor that makes it more difficult to ascertain the direction of colonization which varies between taxa is the relative closeness of the Philippine islands to each other (Jones et al. 2008). Colonization came from various directions and since the archipelago is close to the Sundaland island of Borneo, much of the biotic affinity is broadly recognizable as Asian although with a significant Australo-Papuan component. For mammals, the Australo-Papuan component is demonstrated by the *Chrotomys* Thomas radiation (which includes *Apomys* Mearns) of "new endemic" rodents (Steppan et al. 2005; Jansa et al. 2006).

If viewed in a deeper time scale, the affinities of the recent species radiation on Luzon may be explained by panbiogeography and the correlation of tectonic features with evolution. While the theory of island accretion is well described for Wallacea, this investigatory angle is hampered by the current lack of information on the timing of island accre-

tion and emergence in that region (Lohman et al. 2011). Dispersal and subsequent allopatry may be the most parsimonious theory to account for species diversification in the region. However certain taxa may reflect the influence of tectonic vicariance (Evans et al. 2009) in coalesced islands like Sulawesi. If vicariance had been a signal for speciation in the proto Philippines, then this signal has been reduced by the effects of the formation of the modern archipelago which facilitated dispersal related allopatry (e.g. post vicariance dispersal).
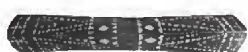
Luzon and Mindanao as hypothesized by Roy Dickerson may have been coalesced archipelagos by themselves. Tectonic uplift and further coalescence made them into the modern archipelago they are today. While there appears to be a signal for vicariance related diversification (e.g. in *Varanus, Scheleffera* and *Rafflesia*), there is not enough information to warrant more inferences. A concerted research effort in floral and faunal biodiversity assessments and the consequent phylogenetic studies are needed to verify the vicariance hypothesis. This research will have to be in tandem with research in tectonics in determining with more accuracy, the timing of island coalescence and accretion and biological speciation.

Luzon shows the signature of being a mini-Sulawesi in terms of tectonic characteristics and its biotic evolution. If this is verified, then the dimensions of biodiversity in the Philippine archipelago will become more complex for it is very likely that islands like Mindanao, Panay, Negros have similar tectonic and evolutionary histories. This fulfils Alfred Russel Wallace's prediction that the geological history of an area can be inferred from its biogeography.

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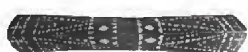
THE ENTOMOLOGICAL SOCIETY OF LATVIA

The Entomological Society of Latvia (ESL) was founded in 1951. The ESL has two subdivisions: the Section of Coleopterology founded in 1996, and the Nature Research Division founded in 1999. The Society has about ~45 members from Latvia, and near 25 members from other countries.

The aims of the Society are: to promote development of entomology in Latvia, to popularise entomological knowledge, to attract members active in fundamental and applied research in entomology, to offer methodological assistance to educational institutions, and to develop international collaboration in entomology and related disciplines.

The investigations carried out by Latvian entomologists are parts of research grants, international projects, or through the initiative of individual members.

The main activities of Latvian entomologists are as follows:

♦   Publication of the journal "Latvijas Entomologs". In 2013, the 52nd issue appeared. The reprints are available in PDF format at http://leb.daba.lv
♦   Participation in NGO activities via comments on drafts of legislative acts, particularly those concerning protected species, and conservation of nature in forests and agricultural lands.
♦   Members of the Society are leaders in expertise concerning invertebrates in the NATURA2000 sites; they monitor species of EU importance and prepare basic information for reporting to the EU Commission. Certified experts provide the needed expertise for the territories where any human activities are planned.
♦   Every year the Society elects an 'Insect of the Year' and an 'Invertebrate of the year', and distributes knowledge about these particular species in mass media, museums, schools etc. The Society has done this for the past 13 years.
♦   Members work with school children promoting the development of their first scientific studies. We also participate in the Nights of Scientists.
♦   The Society organises excursions (in winter, spring and summer) to any of the protected territories to get additional knowledge about the territory and to educate enthusiasts.
♦   The Society implements a limited number of research projects, mostly ordered by governmental institutions.
♦   The Society maintains a library. The library has the largest collection of entomological literature in Latvia, with about 60 library exchange partners over the world.

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